

## THE ROLE OF PAT MARKS IN THE AUSTRALASIAN MOSQUITO CATALOGUE PROJECT AND FUTURE NEEDS IN MOSQUITO TAXONOMY

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### Abstract

Elizabeth Nesta ('Pat') Marks was a major participant in the compilation of the twelve volume annotated bibliography of the mosquito fauna of the Australasian Region. This work provides mosquito workers with easy access to data on all the described species within the region. Pat developed keys for the identification of female specimens of all species within the region.

### Pat Marks' contribution to *The Culicidae of the Australasian Region*

*The Culicidae of the Australasian Region* was a collaborative project initiated by the late Professor David Lee, who was formerly the Head of the Entomology Section of the Sydney School of Public Health and Tropical Medicine. Unfortunately David died soon after the completion of this work but Pat Marks lived to enjoy its completion (Fig. 1).

The Australasian Region includes Australia, New Zealand, New Guinea and islands north to the equator and east to 180°E. It is defined in the northwest by a line drawn around the western coast of the Moluccas, Ceram and Timor. The volumes also cover islands to the north of the Equator such as Hawaii, Kiribati and Tuvalu (formerly known as the Gilbert and Ellice Islands). Many of the islands in the region have endemic species of mosquitoes. Throughout the tropical areas, mosquito-borne diseases such as malaria, lymphatic filariasis and arboviruses are major public health problems but the entomological skills and resources are limited or nonexistent.

For those of us who work or have worked with control of mosquitoes and the diseases they carry, *The Culicidae of the Australasian Region* has been and will continue to be an invaluable resource. The volumes are of even greater benefit to those working in developing countries where library resources are very limited.

As stated in the introduction to Volume One of this series of publications, the authors attempted to include, for all species of mosquitoes that had been recorded in the region, all the literature relating to their occurrence in the region and important references to these species in literature from other regions. For example, a number of medically important species in the region, notably *Aedes aegypti* (L.), the vector of the viruses that cause dengue fever, have been introduced into the region and a great deal of the literature on their biology, behaviour and role in disease transmission comes from work in other zoogeographic regions.

For each species treated in *The Culicidae of the Australasian Region*, details of the original description are provided, including which stages (adult, whether male or female, larva or pupa) were described, and information is given on the type specimen (stage, sex and where it is located). Some widespread species were named on more than one occasion and Pat's expertise was invaluable in unravelling whether the often meagre descriptions referred to the same or different species. Wherever possible, Pat examined the type specimen in her quest to determine the truth.

For each species, the literature pertaining to that species was listed chronologically with notes indicating the contents. For well studied species, such as *Culex annulirostris* Skuse, the vector of Murray Valley encephalitis virus and Ross River virus, the literature listing is very extensive and in this example covers 26 pages, in spite of the notes attached to each reference being very succinct (e.g. 'Tas distribution', 'seasonal activity', 'abundance', 'Echuca', etc).

The information from the literature was synthesized and summarised to provide information on distribution, biology (including larval habitats), associated species, female host preferences, time and place of biting by females, and relation to disease.

The task of compiling the data from over 3700 articles and reports was massive and is reflected in the size of the finished product. *The Culicidae of the Australasian Region* runs to over 3,000 pages in 12 volumes and includes literature dating from 1810.

A great deal of the value of the checklist is due to its providing information from articles that are inaccessible to most readers. These include reports from Health Departments of small island governments (e.g. annual reports of the Fiji Medical Services), publications of the Armed Forces of Australia and the USA, abstracts of scientific conferences and annual reports of research institutions. Such sources have provided a wealth of information that is not available in the scientific literature. Many of these articles were from Pat's own extensive literature collection. Over 200 articles were not in English and had to be translated before their information could be extracted. The foreign language papers largely reflect the colonial history of the Region, with articles in Dutch on the mosquitoes of West New Guinea [now West Papua] and some German language articles, prior to World War One, on mosquitoes in the northeastern part of what is now Papua New Guinea. Publications from New Caledonia are still being written in French, while much of the literature on the vectors of aperiodic lymphatic filariasis is also in French.

We now have readily available information on 620 species of mosquitoes that are known to occur in the region. For many of these species, no new information has been collected since the publication of *The Culicidae of the Australasian Region*.



**Fig. 1.** Pat Marks (left) and Joan Bryan at the launch of the 12-volume *The Culicidae of the Australasian Region* at the University of Queensland Medical School in 1990.

Brief information is also provided on 74 species that have been wrongly recorded from the Region, either due to misidentification of specimens (especially in the early years, bearing in mind that publications reviewed date from 1810), or because some islands were incorrectly assigned to the Australasian Region (e.g. Palau). Recently developed data retrieval systems have made information in articles published since the completion of *The Culicidae of the Australasian Region* much more readily available so I see no need for a revision.



An outstanding achievement associated with the publication of *The Culicidae of the Australasian Region* was the development of keys to identify female mosquitoes, first to genera, then to subgenera (where applicable - not all genera have subgenera) and to species. For the first time, mosquito workers could identify any female mosquito from within the region. The development of these keys was largely Pat's work. Those of us who have tried to prepare identification keys appreciate that this is a complex and difficult process and requires a detailed knowledge of the morphology of the species. Pat certainly had the right credentials for this work. Without the ability to identify specimens, the collation of information on the individual species would have had little value. With few entomologists in many countries within the region, the keys are a lasting gift to those battling mosquito-borne diseases in our neighbouring countries.

The task of compiling *The Culicidae of the Australasian Region* was far bigger than Pat or her colleague David Lee envisaged. I first became aware of their dream to produce a summary of the literature on the mosquitoes of our Region when I was an honours student in the early 1960s, as Pat voiced her discomfort at her delayed response to David's request for comments on early drafts of the first few volumes. Such a 'delayed response' was a feature of Pat's participation in this work, as many other interests took precedence over this huge, and what must have seemed at times impossible to finish, project. Pat and David, while acknowledging the 'magnitude of the task' in their introduction to Volume One, continued optimistically: 'despite many vicissitudes, production is now under way and we hope the interval between the first and final volume will not exceed two years.' Volume One was published in 1980, but by 1982 only Volume Two had been published. Another seven years and a \$100,000 grant from the Commonwealth Government were needed before their dream became reality. The long delay necessitated an additional bibliography (in Volume 12) to cover literature published after the original bibliography was published in Volume One. Here I would also like to acknowledge the dedicated work by the late Mabel Griffiths, Megan Hicks and Margaret Debenham, ably assisted by Richard Russell, Marilyn Geary and others. Completion of the work was greatly aided by the advent of word processors. In spite of the input by others and technological advances, the work relied on scientific input from Pat and David and without them the task would never have been completed. Many of us have grandiose dreams but few see them realised; we are in the debt of the great dreamers.

### **Future needs in mosquito taxonomy in the Australasian region**

Pat herself recognized many species that remain undescribed and her collections contained specimens of at least 43 undescribed species. Many of these are included in the keys in *The Culicidae of the Australasian Region* under code numbers. Sadly, formal taxonomy fails to attract funding and

no one has followed in Pat's footsteps, so there is no immediate prospect of these morphologically distinct species being described.

We also need descriptions and names for those species that cannot be identified by their morphological features, either because they are identical morphologically to other species or they share a variable morphology with other species. An extreme example of this problem is highlighted by *Anopheles annulipes* (Walker), once thought to be a single species. Molecular genetic techniques have revealed the presence of 18-25 species that conform to the description of *An. annulipes* (Foley *et al.* in press).

The importance of correct identification of morphologically indistinguishable species is well illustrated by two species that occur in the Solomon Islands. They would both be identified as *Anopheles farauti* Laveron using the keys in *The Culicidae of the Australasian Region*. However, one species, now named *An. irenicus* Schmidt (Schmidt *et al.* 2003), does not feed on humans and therefore is not implicated in transmission of malaria, whereas *An. farauti* is the major vector of malaria throughout the southwestern Pacific. The presence of larvae of *An. irenicus* could cause control efforts to be misdirected. We need good identification tools before we can develop appropriate control strategies.

For most genera, identification keys for larvae still need to be developed. Given the high degree of endemism, keys for the species within each country will be more appropriate and easier to develop than keys for all species within the region. Keys have been constructed for container-breeding larvae in some South Pacific countries but much remains to be done.

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